



Alternative: Optimize Reservoir Management / Increase Allowable Storage

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1. Summary of the Alternatives

The usability of a given surface water supply is influenced by the management of its storage. The quality of storage management affects the timing of water delivery and associated storage and conveyance losses. This white paper discusses methods of optimizing the regional water supply through effective management of its storage in reservoirs.

The regional surface water supply in the Jemez y Sangre region is directly influenced by the three major reservoirs in the Rio Chama drainage, Heron, El Vado, and Abiquiu, and the smaller water storage reservoirs in the region, which include McClure, Nichols, Nambe Falls, and Santa Cruz. Management of the Rio Chama reservoirs is affected by San Juan-Chama (SJ-C) Project water. SJ-C Project contractors in the Jemez y Sangre planning region include:

- City of Española: 1,000 acre-feet
- City and County of Santa Fe: 5,605 acre-feet
- Los Alamos County: 1,200 acre-feet
- Pojoaque Valley Irrigation District: 1,030 acre-feet
- San Juan Pueblo: 2,000 acre-feet

The Jemez y Sangre Regional Water Planning Council identified three areas of surface water management for consideration in the development of the regional water plan.

- *Alter management of reservoir storage/release to optimize water supply through limiting losses such as evapotranspiration.* In addition to the existing reservoirs within the region, potential management options could also be developed with the conjunctive use





of Cochiti Lake and Elephant Butte Reservoir. Through securing additional storage from other parties it is possible to store water (particularly SJ-C water) that would otherwise be “lost,” reduce reservoir-related water losses, further manage the timing of releases of water, and/or store additional water.

- *Improve existing holding capacity through dredging of reservoirs.* A reservoir’s water capacity diminishes over time due to the entrapment of sediments. The reduction of water storage volume is dependent upon the age of the reservoir and the rate of sediment deposition. Effective water storage can be increased by removing sediments from the reservoir.
- *Construct new large reservoirs.* Where there are ample supplies of surface water and favorable site conditions, new reservoirs (both large and small) can be constructed. Water storage can be seasonal (for annual needs such as irrigation) or multi-year (for drought cycle water supplies.) The “water cost” of storing water is incurred through surface water evaporation, associated evapotranspiration by vegetation, and seepage.

Optimizing reservoir management could increase the amount of water in storage, thus increasing flexibility for water managers and providing added protection during short-term droughts. New water that could be used to meet growing demand will not be created under this alternative unless it is coupled with other alternatives, such as appropriating flood flows during spill years.

2. Technical Feasibility

2.1 Alter Reservoir Management

Altering the management of water within the existing Rio Chama system of dams is very feasible and has been implemented by some SJ-C contractors. This has had the effect of increasing upstream reservoir storage for individual contractors in the Jemez y Sangre planning area.





As dictated by federal law, contracts, and operating agreements, SJ-C water must be delivered annually from Heron Reservoir, and SJ-C contractors must take delivery of the water or lose that year's contracted amount. If they take delivery from Heron Reservoir, the water has to be beneficially used above Elephant Butte Dam (authorized storage is considered a beneficial use). If the contractor does not have a need for the water or a means to divert the water, the water can either be formally or informally marketed or stored in one of the downstream reservoirs (El Vado and/or Abiquiu). If the quantity needed to be stored is in excess of a contractor's allocated storage space, the contractor can attempt to enter into an agreement with the managing entity of the reservoir storage space (for El Vado, Middle Rio Grande Conservancy District [MRGCD]; for Abiquiu, City of Albuquerque). One-on-one arrangements are negotiated between the parties. Provisions that have been included in some of the past agreements with MRGCD are:

- The MRGCD has the first right to use the water, should it need it.
- A storage fee of \$2 to \$5 per acre-foot per year is charged plus 10 to 20 percent of the stored water, with the other party absorbing the evaporative losses for its water on a prorated basis.

If a holder of a native water right is unable to exercise its full water right due to a lack of storage capacity, it could also attempt to enter into an agreement with an entity who had excess storage capacity (i.e., El Vado and Abiquiu.) This would have to be accomplished in accordance with state water law, the paramount consideration being that such an "exchange" of water would not impair downstream water right holders nor New Mexico's ability to make deliveries under the terms of the Rio Grande Compact.

When the City of Albuquerque begins direct use of its SJ-C allocation (currently scheduled for 2006), it is anticipated that more of its New Mexico State Engineer-permitted 170,900 acre-feet of conservation space in Abiquiu Reservoir will be available for use by other SJ-C contractors. However, in the interim period before the proposed diversion project comes on line, the City will be storing greater quantities of its SJ-C project water in Abiquiu, thereby reducing the amount of space available to other water users. Space in the Abiquiu Reservoir allocated in 2001 to SJ-C





contractors above the City of Albuquerque's 170,900 acre-feet, but within the easements owned by the City, consists of:

- City of Española: 1,275 acre-feet
- City of Santa Fe: 7,147 acre-feet
- Los Alamos County: 1,530 acre-feet

Directly storing water further downstream in Cochiti Lake and Elephant Butte Reservoir would be theoretically possible. Additional federal legislation and approval by the U.S. Army Corps of Engineer, New Mexico Office of the State Engineer, Cochiti Pueblo, Bandelier National Park, and the U.S. Forest Service would be required for storing water in Cochiti Lake. The storing entity would store SJ-C water in Cochiti Lake, store or use native water at an upstream location, and then release equivalent volumes from Cochiti to be beneficially used above Elephant Butte. The State Engineer would have to determine that water rights between the point of native water storage and diversion and Cochiti Lake would not be impaired, as well as calculate differential transit losses. For Elephant Butte, SJ-C contractors could enter into an agreement with the City of Albuquerque to store water in its 50,000-acre-foot pool. However, complicated exchanges would have to be negotiated for the contractor to recoup its use of the stored water.

Altering reservoir management on the tributaries is not considered likely because of limited storage capacity (approximately 2,680 acre-feet in Santa Cruz, 1,940 acre-feet in Nambe Falls, 3,260 acre-feet in McClure, and 680 acre-feet in Nichols). Storage space in these reservoirs is already used to maximum capacity by current water right holders.

The principle of reducing evaporation losses by storing water at higher elevations is sound. If choices are available, water users seek opportunities to store their water as high in the system as possible. Based on pan evaporation data, surface evaporation as compared to El Vado Reservoir is 135 percent greater at Elephant Butte, 65 percent greater at Cochiti, and 45 percent greater at Abiquiu. The ratio of surface area to volume also greatly affects the calculated per-acre-foot evaporation. For example, a reservoir holding 1,000 acre-feet with a surface area of 10 acres would have a smaller per-acre-foot evaporative loss than a reservoir storing the same 1,000 acre-feet that has a surface area of 50 surface acres.





2.2 Remove Sediment

There are no technological barriers to removing sediment from a reservoir basin. Several methods of removal are possible:

- The water could be drained to expose the sediments, which would then be excavated using conventional heavy equipment. The sediment would be hauled away and disposed in an upland area. Access roads to the removal and disposal sites would likely have to be constructed.
- It is also technologically feasible to dredge sediment “in the wet,” that is, with water still in the reservoir.
- Sediments could be sluiced through the dam’s outlet works. This method requires partially or completely draining the reservoir, then passing large quantities of water through the exposed sediments at velocities necessary to transport the sediment. This method would remove a relative small proportion of the total sediments in the reservoir basin.

Any drainage of a reservoir to facilitate the removal of sediments could be scheduled when the reservoirs are low, thereby reducing water losses.

2.3 Construct New Large Reservoirs

From an engineering standpoint, there are inevitable technological challenges to constructing new reservoirs, but few absolute barriers that cannot be overcome through investments of additional funds. The engineering barriers to any given dam site are dictated by geologic conditions, such as the lack of stable abutments and footings for the dam, high seismic risk, or unfavorable geology in the reservoir area that would result in excessive seepage losses.

In addition to building new reservoirs, it is possible that existing dams could be modified to increase the storage capacity of their associated reservoirs. A 1981 Bureau of Reclamation





appraisal-level study (USBR, 1983) concluded that it was "engineeringly feasible" to raise the crest of the Santa Cruz Dam. In 1995, concurrent with completing safety of dams work, the City of Santa Fe increased the capacity of McClure Reservoir by modifying the dam's spillway (personal communication with Frank Bailey, City of Santa Fe, January 7, 2002).

Also, whereas Abiquiu Reservoir has a total potential capacity of about 1.5 million acre-feet, the current federal authorization limits conservation storage to only 200,000 acre-feet (which includes the sediment pool), and all the existing easements for allowable storage (183,246 acre-feet) are owned by the City of Albuquerque (170,900 acre-feet) and the U.S. Army Corps of Engineers (12,346 acre-feet). It is physically possible to store more water in the existing reservoir, but easements must be obtained. The Corps of Engineers has congressional authorization for approximately 17,000 additional acre-feet of storage in Abiquiu Reservoir if an easement can be secured. This increased storage capacity could help the region over the short term until SJ-C water is fully diverted. Storage in amounts above the 200,000 acre-feet approved by Congress would result in the inundation of homes and roads and would require congressional authorization. The added storage would be beneficial during high flow years, but could have negative ecological and scenic consequences.

3. Financial Feasibility

3.1 *Alter Reservoir Management*

Altering reservoir management is financially feasible on the Rio Chama mainstem. As a hypothetical example, a SJ-C contractor wishing to store 1,000 acre-feet of SJ-C water in El Vado Reservoir (assuming the space is available) might pay the MRGCD 150 acre-feet (15 percent water charge) and \$3,500 (\$3.50 per acre-foot) for one year's storage, plus a prorated share of evaporative losses.

For Abiquiu, SJ-C contractors with temporary allocations of storage space in the City of Albuquerque-owned space currently pay a prorated share of operation and maintenance (about 30 cents per acre-foot) to the U.S. Army Corps of Engineers. Terms of using *additional* storage space in Abiquiu within Albuquerque's 170,900-acre-foot pool would have to be negotiated with





the City of Albuquerque. It is expected that there would be a monetary cost per acre-foot, a proportional share of evaporative losses, and possibly a water charge.

When considering evaporative loss charges, the differences among reservoirs need to be taken into account, as they will have a direct impact on the storage cost per acre-foot of water recovered from storage.

3.2 Remove Sediment

Based upon the Bureau of Reclamation's aforementioned study of the Santa Cruz dam and reservoir, in Year 2000 dollars, sediment removal would cost about \$14,500 per acre-foot (e.g., removal of 1,000 acre-feet of sediment would cost about \$14.5 million). At that time, the Bureau of Reclamation determined sediment removal was not a financially practical solution (USBR, 1983).

A 2001 study performed under contract to the U.S. Army Corps of Engineers concluded that two canyons at the upper end of Santa Cruz Reservoir had the capacity for the disposal of 367 acre-feet of sediment. This removal and disposal would cost about \$2.75 million, or about \$7,500 per acre-foot. The presumed difference in estimated costs is due to on-site disposal (Resource Technology, Inc., 2002).

3.3 Construct New Large Reservoirs

Because the construction costs for a dam are determined by its specific site, it is impossible to estimate the costs of constructing new dams. However, as points of reference, the original construction costs of Nambe Falls Dam and Reservoir and Heron Dam and Reservoir, indexed to Year 2000, were about \$30 million and \$50 million, respectively.

In terms of benefits, a 2001 study addressing Rio Grande Basin water management during prolonged droughts concluded that the construction of a 100,000-acre foot reservoir above Cochiti Reservoir would produce long-run average annual *collective* benefits to New Mexico water users of only \$134,000 (Ward et al., 2001).





The Bureau of Reclamation study for Santa Cruz Dam determined that to raise the dam 13 feet (increasing storage by 1,310 acre-feet), appraisal-level estimates (indexed to Year 2000 dollars) were about \$11.5 million; to raise the dam 23 feet (increasing storage 2,600 acre-feet) was estimated to cost about \$12.8 million (USBR, 1983). However, the modification of the McClure Dam spillway, increasing storage by 500 acre-feet, cost the city of Santa Fe about \$1 million (personal communication with Frank Bailey, City of Santa Fe, January 7, 2002).

The primary costs for storing additional water in Abiquiu Reservoir, beyond the planning and compliance expenses, would be acquiring land easements. No estimates of costs are available.

3.4 Financing

Because of the high costs associated with sediment removal, dam modification, or dam construction, project beneficiaries would likely need federal and/or state funding, which would require repayment contracts. Local repayment could be accomplished through increasing water user fees and issuing bonds. Grants, which normally require local cost-sharing, could be pursued for planning studies and compliance activities.

Costs to local beneficiaries could theoretically be reduced or eliminated by entering into contracts with third parties (municipal and industrial water users) whereby the third party would pay for some or all of the construction and operation and maintenance costs in exchange for some portion of the developed water.

4. Legal Feasibility

Of the three alternatives, changes in storage/release management in general would require less demanding legal authorization (Section 4.1). The second alternative, restoring reservoir capacity through dredging likewise involves a less demanding legal process (Section 4.2). The third alternative, expansion of existing reservoirs and/or construction of new reservoirs is more legally demanding, requiring multiple authorizations at state and federal levels and would be subject to the Rio Grande Compact's post-1929 storage restrictions on native water.





4.1 Alter Reservoir Management

Altering management of existing reservoirs to optimize water supply presents a relatively moderate level of legal restraint, as long as the change in use does not increase depletions beyond the recognized right. Any proposed increase in depletions above existing rights would require acquisition and approval of additional rights, as discussed in Section 4.3.

The first legal authorization needed for changes in reservoir operations will be from the owner/operator of the reservoir. On the Chama/Rio Grande main stem, rights to excess storage capacity could be obtained by agreement with the managing entity, MRGCD, with respect to El Vado Reservoir and with the City of Albuquerque with respect to Abiquiu Reservoir. Although Abiquiu Reservoir has a capacity of 1.5 million acre-feet, federal legislation would be required to store water in Abiquiu above the total authorized storage amount of 200,000 acre-feet. Likewise, in addition to needing approval by the U.S. Army Corps of Engineer, Office of the State Engineer, Cochiti Pueblo, Bandelier National Park, and the U.S. Forest Service, storage in Cochiti Reservoir would require federal legislation allowing the storage. Storage in Cochiti of a native right vested above the Otowi gage would also have to comply with transfer requirements imposed by the Rio Grande Compact, as discussed in another white paper (DBS&A, 2002c).

In addition to owner/operator approval, one seeking increased storage in tributary reservoirs (i.e., Santa Cruz, Nambe Falls, McClure and Nichols) would have to contend with impairment of water rights holders on the tributary below the reservoir dam, even where SJ-C is the source of supply, because, in effect, tributary storage of SJ-C water would most likely be achieved through an exchange, thereby diminishing tributary native flows.

In order to protect other water rights holders and to assure deliveries under the Rio Grande Compact, the State Engineer will only permit storage of a native right if the change does not increase the total depletion beyond that allowed by the right. In addition, the State Engineer would require a no-injury analysis demonstrating that storage does not impair intervening water right holders, that is, those diverting between the point of storage and the established point of diversion or the point that exchange water (i.e., SJ-C) is introduced in replacement.





Finally, although management modifications are the least likely of the three alternatives discussed on this topic to affect the environment, changes in the hydrograph would have to be considered, as discussed in Section 4.3. In addition, new storage would be subject to the post-1929 restrictions of the Rio Grande Compact, also as discussed in Section 4.3.

4.2 Removal of Sediment

Restoring reservoir capacity should not require acquisition and transfer of additional water rights, as long valid rights exist for the larger capacity. Nonetheless, increased storage capacity and with it full use of a recently dormant right will result in more water being depleted. On water-short tributaries in particular, full exercise even of a valid right could result in the curtailment of that right by priority administration if senior rights do not get their full historical supply.

The main legal obstacle to reservoir dredging is environmental effects. The environmental requirements applying to reservoir construction and expansion, as discussed in Section 4.3, would generally apply to dredging; however, maintenance of an existing reservoir should pose far less of an environmental concern in terms of on-site effects. The primary environmental issue would be disposal of dredged material and/or downstream water quality and siltation effects, especially if sluicing is used as a dredging method.

4.3 Construct New Large Reservoirs.

Construction of new reservoirs and major expansion of existing reservoirs would present the most legal hurdles of the three alternatives. Any increase in the amount of water already permitted to be stored would require a new permit from the State Engineer. If storage results in increased depletions, the party proposing to increase storage would either have to use SJ-C water or transfer native water rights to offset the new depletions or would have to obtain a State Engineer permit to appropriate water in the amount of the new depletions. To transfer (i.e., to change its point of diversion and/or place and/or purpose of use) a water right, an applicant must show that the transfer (1) will not impair other water rights, (2) is not contrary to conservation, and (3) is not detrimental to public welfare (§§72-5-23, 72-12-7 NMSA 1978 (1997





Repl.)). Generally, the surface waters of the planning region are considered to be fully appropriated, and therefore the State Engineer is not likely to issue a permit to appropriate additional amounts of water, except perhaps for potentially available flood flows, as discussed in the white papers on appropriating above-average runoff flows (DBS&A, 2002a) and potentially available water above the Otowi gage (DBS&A, 2002b).

Construction of dams is also regulated by the State Engineer (§72-5-32). Before constructing a dam, one must obtain a permit from the State Engineer (and meet the statutory criteria: not cause impairment of any existing water rights, not be detrimental to the public welfare, and not be contrary to the conservation of water) (§72-5-6). Dams that are exempted from State Engineer permitting include “erosion control structures whose maximum storage capacity does not exceed ten acre-feet,” and “dam[s] constructed for the sole purpose of sediment and flood control under the supervision of the United States army corps of engineers.” (Until 1997, no dams that were less than 10 feet in height and that impounded less than 10 acre-feet were subject to State Engineer regulation. In 1997, the legislature amended §72-5-32 to greatly restrict that exemption).

A new reservoir or an expanded reservoir would require authorization from the affected landowner, which in most cases would be the federal government. In the national forests, dam construction and reservoir expansion or creation must comply with the National Forest Management Act, 16 U.S.C. §1600, *et seq.* (NFMA). In addition, other federal laws would apply: the National Environmental Policy Act, 42 U.S.C. §4321 *et seq.* (NEPA), the Clean Water Act, 33 U.S.C. §1251 *et seq.* (CWA), the Endangered Species Act, 16 U.S.C. §1531 *et seq.* (ESA), and possibly the National Historic Preservation Act, 16 U.S.C. §470 *et seq.* (NHPA) and the American Indian Religious Freedom Act, 42 U.S.C. §1996 (AIRFA). Most of the constraints placed by these laws relate to process, studies, and planning that must be done before significant surface-disturbing work is done. There will, however, also be substantive constraints on how much earthmoving, logging, and road-building can be done. NFMA places limits on methods and locations of earthmoving, logging, and road-building (e.g., limiting clear-cuts and similarly extreme methods of logging, prohibiting logging on very steep slopes, limiting logging adjacent to rivers). The ESA may limit these actions where species listed as threatened or endangered are located. The CWA will come in to play because dams or dikes or any





diversions that are constructed in arroyos or streams, which are considered “waters of the United States,” are subject to CWA jurisdiction and will require a permit from the Army Corps of Engineers under §404 (33 U.S.C. §1344). The bigger the land disturbance, the more onerous the permit conditions will be. AIRFA and NFMA may limit land disturbance near sites of religious, cultural, or historical significance. In addition, some local governments, such as Santa Fe County, impose environmental and land use constraints on logging and road-building in national forests within the county’s jurisdiction (e.g., no land disturbance on very steep slopes, no logging or road-building on ridgelines).

Finally, the Rio Grande Compact of 1938 places restrictions on storage of water (§72-15-23 NMSA 1978 (1997 Repl.)). Under Article VI of the Compact, New Mexico’s accrued debit shall not exceed 200,000 acre-feet at any time, except as such debit may be caused by holdover storage of water in reservoirs constructed after 1929; however, New Mexico shall retain water in storage at all times to the extent of its accrued debit. This means that the water could not be released for any local use, but must be held for release to Texas if called upon. Under Article VII, New Mexico in general shall not increase the amount of water in storage in reservoirs constructed after 1929 whenever there is less than 400,000 acre-feet of usable water in project storage in Elephant Butte and Caballo Reservoirs. Finally, under Article VIII, Texas may demand release of water from storage reservoirs constructed after 1929 to the amount of the accrued debits of New Mexico and Colorado, sufficient to bring the quantity of usable water in project storage to its regular annualized amount of 790,000 acre-feet. This affects El Vado, Abiquiu, Nambe Falls, and McClure Reservoirs, all of which were constructed after 1929; Nichols (1946), Two Mile (1894), and Santa Cruz (1929) Reservoirs are not regulated by the Compact. To avoid a Texas call on water stored in a post-1929 reservoir, the party storing the called water may leave the water in storage by substituting other water, such as SJ-C water.





5. Effectiveness in Either Increasing the Available Supply or Reducing the Projected Demand

5.1 *Alter Reservoir Management*

The system of reservoirs in or impacting the Jemez y Sangre planning region is currently well managed. Water users are expected to continue to exploit opportunities to store water in El Vado and Abiquiu as the needs and opportunities arise. Non-monetary storage fees associated with storing water in El Vado versus Abiquiu would likely negate the savings in evaporative losses associated with moving storage from Abiquiu to El Vado. The evaporative losses realized in storing water in Cochiti Lake, and especially Elephant Butte Reservoir, would have to be considered carefully before pursuing these potentials. This option has the potential to affect the annual management of the 10,835 acre-feet of annually contracted water, as well as any other SJ-C water being held in upstream storage.

5.2 *Remove Sediment*

For the larger reservoirs (i.e., Heron and Abiquiu), sedimentation is not an issue because of its small proportion relative to the total storage volume of the reservoir. Sediment accumulations in smaller reservoirs, however, can significantly reduce the available storage capacity. For every acre-foot of sediment removed from a reservoir, there would be an acre-foot of additional water storage space. Therefore, this option must be considered technically effective. The approximate current sediment accumulations in the smaller reservoirs are:

- Santa Cruz: 1,800 acre-feet
- McClure: negligible
- Nambe Falls: 100 acre-feet

Although additional hydrologic analyses would be required, a review of reservoir hydrographs and relevant stream gages indicates that there are adequate inflows into both Santa Cruz and Nambe Falls reservoirs to take advantage of recouped storage space (inflow data are not available for McClure).





5.3 Construct New Large Reservoirs

The construction of new large reservoirs would be effective in increasing storage space, which could replace space lost to sedimentation and/or store additional water. The storage of additional water would be limited to those periods when spring runoff or precipitation events generated water in excess of current storage capacity, and when such storage would not negatively impact New Mexico's ability to comply with its Rio Grande Compact water delivery obligations. The location of the reservoir(s) would affect both the amount of water lost during storage and the transit losses from the reservoir to the point(s) of diversion.

6. Environmental Implications

6.1 Alter Reservoir Management

The environmental issues associated with modifying reservoir management are the least burdensome of the three categories of options. The principal issue would be the modification of the shape of the hydrograph downstream from the points of storage and release. This would affect the fisheries, including the brown trout fishery between El Vado Dam and Abiquiu Reservoir, and the long-term health of riparian community. There could also be effects on endangered species, most notably the Rio Grande silvery minnow and the Southwestern willow flycatcher. In the past, water managers have found enough latitude to minimize environmental impacts associated with modifications to Rio Chama operations resulting from SJ-C contractors' storage agreements.

Multiple adverse in-reservoir environmental impacts from water storage were observed at Cochiti Reservoir in the 1980s, prompting changes in operation. The ecosystem disruptions associated with long-term but fluctuating water levels were not consistent with productive ecosystems or the land management objectives of Cochiti Pueblo, Bandelier National Park, and the Santa Fe National Forest. The operation of Cochiti reservoir has focused on providing temporary water storage consistent with the flood and sediment control authorization. Careful management can meet these temporary storage goals with minimal disruption of the natural





ecological river system where temporary flooding occurs (less than a few weeks in duration) by releasing water in a manner that more closely mimics natural conditions.

6.2 Remove Sediment

There are numerous environmental considerations associated with the mechanical removal of sediments from reservoirs. These include, but are not limited to, mobilization of potential contaminants, physical destruction of riparian vegetation and habitats, construction of access and haul roads, and environmental impacts to disposal sites.

If sluicing the sediment through the dam's outlet works was pursued, the impacts of the increased sediment load on the downstream waterway would be significant and would likely prove to be unacceptable.

6.3 Construct New Large Reservoirs

A wide range of environmental issues are associated with the construction of a new dam. Beyond the immediate effects of the dam and reservoir on the environment, a new dam would affect downstream conditions such as hydrograph, sediment, water temperature, water quality, and river morphology. These effects would also occur if an existing dam was modified, or if additional storage was secured in Abiquiu Reservoir. For this, and all alternatives, the cost of mitigating adverse environmental impacts would be included in the construction and operation and maintenance costs.

7. Socioeconomic Impacts

The Jemez y Sangre region of northern New Mexico is distinguished by its rural and agricultural character, predominantly Indian and Hispano population, localized land-based economies, and pockets of persistent poverty. In particular, its Indian and Hispano populations represent some of the most unique cultures in the world, products of a long history of continuous human habitation, adaptation, and cultural blending. Land-based Indian and Hispano cultures still thrive, carrying on centuries-old cultural traditions that include distinctive land-use and





settlement patterns, agricultural and irrigation practices, natural resource stewardship practices, social relations, religious activities, and architecture. An example is the ancient acequia tradition, which is vital both as a sustainable irrigation system for subsistence and market agriculture and as part of the social glue that holds together rural communities.

The survival of these deeply rooted local traditions is essential for the continuity of rural culture and communities and, in turn, for the local tourism industry, which is built in large part upon the singular cultural and historical personality of the region. Preservation of these traditions is therefore an important consideration in determining the socioeconomic and cultural impacts of regional water planning.

Optimizing reservoir management to limit evaporative losses would have the direct benefit of increasing streamflow for downstream water right owners, including acequias and other traditional uses, thus benefiting the associated socioeconomic and cultural values.

Increasing allowable reservoir storage would negatively impact downstream water users by creating a larger water surface area that would increase evaporative losses. Indirect impacts would involve mostly issues of public perception and, therefore, public acceptance. Local communities are likely to look with suspicion on increased reservoir capacity unless they reap a direct benefit in the form of more water.

With growing environmental sensibilities among the public, new large reservoirs would likely encounter significant public opinion hurdles and probably strident opposition. In addition, the cost of new reservoirs would likely be passed on to consumers, increasing the cost of water.

8. Actions Needed to Implement/Ease of Implementation

8.1 *Alter Reservoir Management*

The water right holders would continue to enter into individual or collective agreements with the managers of the storage space. If agreements were pursued that were outside of the existing New Mexico water rights permits, formal approval of the New Mexico Office of the State





Engineer would be required. The U.S. Army Corps of Engineers would have to be consulted regarding the steps required to initiate consideration of storage in Cochiti Lake.

8.2 Remove Sediment

Feasibility-level studies would have to be completed to review the inflow hydrology to the reservoir in question in order to calculate project costs, identify and quantify the benefits of the increased water supply, evaluate funding sources, and identify related issues. A feasibility study would cost in the neighborhood of \$100,000 to \$250,000 and take one year to complete.

8.3 Construct New Large Reservoirs

Any effort to actually construct a new large reservoir would first require an appraisal-level study to review possible dam and reservoir sites, determine possible sizes based on hydrology and water rights, and identify and quantify potential project beneficiaries. Assuming the results were positive, the next step would be a feasibility study of the favorable option(s) identified in the appraisal study. In total, this could take 3 to 5 years, with a cost of up to \$1 million.

If the region is interested in increasing storage capacity by using Abiquiu Reservoir, the first step would be to secure the 17,000 acre-feet of storage easements in Abiquiu that are within the authorized amount. If an even greater amount of storage capacity is desired, the region should seek authorization from Congress. Increased storage capacity is desirable in the short term for the purpose of increasing the pool of water available to offset the impacts of past well pumping when the City and County of Santa Fe begin diverting water directly from the Rio Grande, rather than through the Buckman Well Field.

9. Summary of Advantages and Disadvantages

Table 1 summarizes the advantages and disadvantages of the three reservoir-related options.





Table 1. Advantages and Disadvantages of Reservoir Options

Alternative	Pros	Cons
Alter reservoir management	<ul style="list-style-type: none">• Few, if any, institutional barriers exist.• Depending on availability of storage space, option can be implemented immediately.• Costs are low.• Environmental issues are comparatively minor.	<ul style="list-style-type: none">• For next 5 years, available storage space could be very limited.• As entities develop methods to divert surface water, amount of water needing storage space would be reduced.• Opportunities are unlikely to be available for tributary reservoirs, and if available, would accommodate only small amounts of water.
Remove sediment	<ul style="list-style-type: none">• All or a portion of storage lost to sediment deposition can be restored.• Adequate water supply likely exists.	<ul style="list-style-type: none">• Costs are high.• Significant environmental issues exist.
Construct new large reservoirs	<ul style="list-style-type: none">• Water in excess of New Mexico's Rio Grande Compact delivery obligations could periodically be captured without harming downstream water right holders.	<ul style="list-style-type: none">• Costs are high.• Significant environmental issues exist.• There are likely few hydrologic opportunities to store water.• Institutional considerations exist.• Difficulty in finding suitable location(s)

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